

1    **CLAIMS**

2           1.    An audio watermarking system comprising  
3           a pattern generator to generate both a strong watermark and a weak  
4    watermark; and  
5           a watermark insertion unit to insert the strong watermark and the weak  
6    watermark into the audio signal.

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8           2.    An audio watermarking system as recited in claim 1, wherein the  
9    watermark insertion unit selectively inserts the strong watermark or the weak  
10   watermark into segments of the signal according to an audible measure of the  
11   segments.

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13          3.    An audio watermarking system as recited in claim 1, further  
14   comprising:  
15          a processor to determine a hearing threshold for the audio signal; and  
16          the watermark insertion unit inserts the strong watermark when the signal  
17   exceeds the hearing threshold and insert the weak watermark when the signal falls  
18   below the hearing threshold.

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20          4.    An operating system comprising an audio watermarking system as  
21   recited in claim 1.

22  
23          5.    An audio watermark encoding system comprising:  
24          a converter to convert an audio signal into magnitude and phase  
25   components;

1 a mask processor to determine a hearing threshold for corresponding  
2 magnitude components;

3 a pattern generator to generate both a strong watermark and a weak  
4 watermark; and

5 a watermark insertion unit to selectively insert one of the strong watermark  
6 or the weak watermark into the audio signal based on whether the magnitude  
7 components exceed or fall below the hearing threshold.

8  
9 6. An audio watermark encoding system as recited in claim 5, wherein  
10 the watermark insertion unit inserts the strong watermark when the magnitude  
11 component exceeds the hearing threshold and inserts the weak watermark when  
12 the magnitude component falls below the hearing threshold.

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14 7. An audio watermark encoding system as recited in claim 5, wherein  
15 the watermark insertion unit inserts the strong watermark when the magnitude  
16 component exceeds the hearing threshold by a predetermined amount and inserts  
17 the weak watermark when the magnitude component falls below the hearing  
18 threshold by the predetermined amount.

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20 8. An audio watermark encoding system as recited in claim 7, wherein  
21 the watermark insertion unit foregoes inserting the strong watermark or the weak  
22 watermark when the magnitude component lies within the predetermined amount  
23 above and below the hearing threshold.

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1           **9.**    An audio encoding system comprising:  
2           an audio watermark encoding system as recited in claim 5; and  
3           a compression unit, wherein the compression unit and the audio watermark  
4 encoding system both utilize the magnitude components.

5  
6           **10.**   An operating system comprising an audio watermark encoding  
7 system as recited in claim 5.

8  
9           **11.**   A watermark insertion unit, comprising:  
10          an input to receive frequency magnitude components of an audio signal,  
11 hearing thresholds derived from the magnitude components, strong watermark  
12 values, and weak watermark values; and  
13          multiple insertion operators for selectively combining the magnitude  
14 components and one of the strong watermark values or the weak watermark values  
15 depending upon whether the magnitude components exceed or fall below the  
16 hearing thresholds.

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18          **12.**   An audio watermark detection system, comprising:  
19          a synchronization module to determine which portion of a watermarked  
20 audio signal might contain a watermark; and  
21          a correlation module to detect whether a strong watermark and a weak  
22 watermark is present in the portion of the watermarked audio signal.

1       **13.**    An audio watermark detection system as recited in claim 12,  
2    wherein the correlation module computes a correlation value from the  
3    watermarked audio signal and the strong watermark that tends toward a first value  
4    when the strong watermark is present and a second value when the strong  
5    watermark is not present.

6  
7       **14.**    An audio watermark detection system as recited in claim 12,  
8    wherein the correlation module computes a correlation value from the  
9    watermarked audio signal and the weak watermark that tends toward a first value  
10   when the weak watermark is present and a second value when the weak watermark  
11   is not present.

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13       **15.**    An audio watermark detection system as recited in claim 12,  
14   wherein the correlation module computes a correlation value from the  
15   watermarked audio signal and one of the strong watermark or the weak  
16   watermark, the correlation module determining that said one strong watermark or  
17   weak watermark is present when the correlation value exceeds a predetermined  
18   threshold plus a random amount.

19  
20       **16.**    An operating system comprising an audio watermark detection  
21   system as recited in claim 12.

22  
23       **17.**    An audio watermark detection system comprising:  
24       a converter to convert a watermarked audio signal into magnitude and  
25       phase components;

1 a mask processor to determine a hearing threshold for corresponding  
2 magnitude components;

3 a pattern generator to generate both a strong watermark and a weak  
4 watermark; and

5 a watermark detector to detect presence of the strong watermark and the  
6 weak watermark in the audio signal.

7  
8 **18.** An audio watermark detection system as recited in claim 17,  
9 wherein the watermark detector computes correlation values from the  
10 watermarked audio signal and each of the strong watermark and the weak  
11 watermark and detects the presence of the strong watermark and the weak  
12 watermark based on whether the correlation values exceed a predetermined  
13 threshold.

14  
15 **19.** An audio watermark detection system as recited in claim 17, further  
16 comprising:

17 a random operator for generating a random value; and

18 the watermark detector computes correlation values from the watermarked  
19 audio signal and each of the strong watermark and the weak watermark and  
20 detects the presence of the strong watermark and the weak watermark based on  
21 whether the correlation values exceed a predetermined threshold plus the random  
22 value.

23  
24 **20.** An audio decoding system comprising:

25 an audio watermark detection system as recited in claim 17; and

1 a decompression unit, wherein the decompression unit and the audio  
2 watermark detection system both utilize the magnitude components.

3  
4 **21.** An operating system comprising an audio watermark detection  
5 system as recited in claim 17.

6  
7 **22.** An audio watermarking architecture, comprising:  
8 a watermark encoding system to insert a strong watermark and a weak  
9 watermark into an audio signal; and  
10 a watermark detecting system to detect a presence of the strong watermark  
11 and the weak watermark in the audio signal.

12  
13 **23.** An audio watermarking architecture as recited in claim 22, wherein  
14 the watermark encoding system resides at a content producer to watermark  
15 original audio content and the watermark detecting system resides at one or more  
16 clients to detect the watermarks and play the original audio content.

17  
18 **24.** An audio watermarking architecture as recited in claim 22, wherein  
19 the watermark encoding system comprises:

20 a converter to convert the audio signal into magnitude and phase  
21 components;

22 a mask processor to determine a hearing threshold for corresponding  
23 magnitude components;

24 a pattern generator to generate both the strong watermark and the weak  
25 watermark; and

1 a watermark insertion unit to selectively insert one of the strong watermark  
2 or the weak watermark into the audio signal based on whether the magnitude  
3 components exceed or fall below the hearing threshold.  
4

5 **25.** An audio watermarking architecture as recited in claim 22, wherein  
6 the watermark detecting system comprises:

7 a converter to convert a watermarked audio signal into magnitude and  
8 phase components;

9 a mask processor to determine a hearing threshold for corresponding  
10 magnitude components;

11 a pattern generator to generate both a strong watermark and a weak  
12 watermark; and

13 a watermark detector to detect presence of the strong watermark and the  
14 weak watermark in the audio signal.  
15

16 **26.** A method for watermarking an audio signal, comprising:  
17 watermarking a first portion of the audio signal with a strong watermark;  
18 and  
19 watermarking a second portion of the audio signal with a weak watermark.  
20

21 **27.** A method for watermarking an audio signal, comprising:  
22 comparing samples of the audio signal to a hearing threshold;  
23 watermarking samples exceeding the hearing threshold with a strong  
24 watermark; and  
25

1 watermarking samples falling below the hearing threshold with a weak  
2 watermark.

3  
4 **28.** A method as recited in claim 27, wherein the watermarking samples  
5 comprises:

6 watermarking samples exceeding the hearing threshold plus a buffer value  
7 with a strong watermark;

8 watermarking samples falling below the hearing threshold by less than the  
9 buffer value with a weak watermark; and

10 leaving samples lying within the buffer value above and below the hearing  
11 threshold without a watermark.

12  
13 **29.** A method as recited in claim 27, further comprising detecting the  
14 strong watermark and the weak watermark in the audio signal.

15  
16 **30.** A method as recited in claim 29, wherein the detecting comprises  
17 computing a correlation value from the audio signal and the strong watermark, the  
18 correlation value tending toward a first value when the strong watermark is present  
19 and a second value when the strong watermark is not present.

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21 **31.** A method as recited in claim 29, wherein the detecting comprises  
22 computing a correlation value from the audio signal and the weak watermark, the  
23 correlation value tending toward a first value when the weak watermark is present  
24 and a second value when the weak watermark is not present.



1           **32.**    A method as recited in claim 27, further comprising:  
2           computing a correlation value from the audio signal and one of the strong  
3 watermark or the weak watermark; and  
4           determining that said one strong watermark or weak watermark is present  
5 when the correlation value exceeds a predetermined threshold plus a random  
6 amount.

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8           **33.**    A method comprising:  
9           encoding an audio signal with both a strong watermark and a weak  
10 watermark; and  
11          detecting a presence of the strong watermark and the weak watermark in  
12 the audio signal.

13  
14          **34.**    A computer readable medium having computer executable  
15 instructions for:  
16          watermarking a first portion of an audio signal with a strong watermark;  
17 and  
18          watermarking a second portion of the audio signal with a weak watermark.

19  
20          **35.**    A computer readable medium having computer executable  
21 instructions for:  
22          comparing samples of an audio signal to a hearing threshold;  
23          watermarking samples exceeding the hearing threshold with a strong  
24 watermark; and  
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watermarking samples falling below the hearing threshold with a weak watermark.